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EDITORIAL

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Editorial for the Thematic Series in *Agriculture & Food Security*: Climate-Smart Agriculture Technologies in West Africa: learning from the ground AR4D experiences

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This Thematic Series on "Climate-Smart Agriculture Technologies in West Africa: learning from the ground AR4D experiences" contains seven papers presented by researchers from four West African countries based on participatory action research conducted since 2012 in the region. These research activities were funded by the CGIAR Research Program on Climate Change Agriculture and Food Security (CCAFS) through a project titled "Developing community-based climate-smart agriculture through participatory action research in CCAFS benchmark sites in West Africa" (see [1]). This research action under the scientific lead of the World Agroforestry Centre (ICRAF) aimed to test and validate, in partnership with rural communities and other stakeholders, scalable climate-smart village models for agricultural development that integrate a range of innovative agricultural risk management strategies. The project also aimed to enable farmers, developers, managers and policy makers for the agriculture sector to develop cost-effective climate-smart agriculture (CSA) options that support local sustainable development and enhance livelihood resilience. It is therefore a response to the challenges (degraded lands, low crop productivity, high level of poverty for rural people, etc.) faced to satisfy the food needs of an increasing population in the face of a changing climate.

Indeed, FAO [2] has estimated that to feed the world population, food production needs to increase by at least 70% by 2050, and this increase in demand will be much greater in sub-Saharan Africa [3, 4]. In the region, although soil fertility is known as one of the major challenges faced by agriculture [5, 6], climate change and variability add extra burdens [4]. Indeed, the livelihoods of people in the region depend on rain-fed agriculture and livestock [7], which are known to be the most vulnerable to climate change [8, 9] with serious threats to food security.

Therefore, managing agricultural production risk is of paramount importance in the context of a crucial need of improving food security and sustaining rural economies [10, 11]. In the light of this, a holistic concept of agriculture production, climate-smart agriculture (CSA), is proposed as a solution to transform and reorient agricultural systems to support food security under the new realities of climate change. CSA consists of co-achieving three objectives, or pillars, defined as: (1) sustainably increasing agricultural productivity to support equitable increases in incomes, food security and development; (2) adapting and building resilience to climate change from the farm to national levels; and (3) reducing or removing GHG emissions where possible [12, 13].

As there are huge variations between geographic locations and socio-economic conditions in terms of risks to be faced and capacities to face them, CSA thrives to engage context-specific and locally adapted actions and interventions, along the whole agricultural value chain [7]. In the same line, it is believed that the management of natural and human resources of agricultural production at the very local level determines the success or failure in closing the yield gap [14]. However, evidences on options that can guarantee attainment of the objectives set forth by CSA concept are yet to be documented, and it is the intent of this Thematic Series to share findings and lessons from attempts to evaluate some of these options.

The options evaluated here were trialled in the frame of the climate-smart village (CSV) Agricultural Research for Development (AR4D) approach developed by CCAFS to

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stimulate scaling of CSA. This approach is founded on the principles of participatory action research, for grounding research on appropriate and location-/context-specific enabling conditions, generating greater evidence of CSA effectiveness in a real-life setting and facilitating co-development of scaling mechanisms towards landscapes, subnational and national levels [12]. In this AR4D approach, CSVs are: (1) multi-stakeholder learning platforms; (2) participatory test beds for generating greater evidence of CSA effectiveness; and (3) cornerstones to draw out scaling lessons for policy makers from local to global levels. CSA is seen in a broad sense, including practices, technologies, services and institutional options (Fig. 1).

It is in line with such CSV AR4D approach that in this Thematic Series, Sanogo et al. [15] studied the implementation of the whole process in the Kaffrine region in Senegal. Their paper covers four interdependent groups of activities/domains (encompassing the different components in Fig. 1), namely local and institutional knowledge, the use of climate information services, the development of climate-smart technologies and how all this fits into local development plans. This work also documented how the approach is perceived by farmers in comparison with previous approaches.

One of the critical steps in the CSV AR4D approach is the creation of evidences through evaluation and development of portfolios of climate-smart interventions that could easily be out- and upscaled. This includes biophysical agricultural options as tested, validated and reported, in this Thematic Series, by Sanou et al., Buah et al. and Traoré et al. [16–18] who document evidences on how tillage methods, fertilization, crop varieties and cropping systems under varying rainfall conditions in Burkina Faso, Ghana and Mali have impacted productions (Fig. 1: component CSA practices and technologies). Evidences are also needed on how the provision of agricultural-related services, notably climate information services, helps improve the management of climate risks. This is the subject of the paper by Etwire et al. [19] who aimed to understand drivers of farmers' decision to use climate-related agriculture services, their perception of the usefulness of such services, and constraints associated with their use (Fig. 1: component climate information services and insurance).

In general, ligneous resources are important contributors to livelihood needs in farming communities [20, 21], and this could be especially true in the context of climate change. In the Sahel particularly, when annual crops do not provide sufficient food, local population relies on ligneous resources in their adaptation strategies. Therefore, a better understanding of the interactions between the different communities and tree resources could guide management practices for an optimized contribution of these resources to resilience efforts. The paper by Ouedraogo et al. [22] tackles such issues and presents data on the uses and vulnerability of ligneous species exploited by local population of northern Burkina Faso in their adaptation strategies to changing environments (Fig. 1: component farmers' knowledge). Also, despite harsh conditions, some species thrive in specific sites, making identification of those species and their potential preferred microsites a great step towards their sound regeneration and safeguard for continuous provision of population tree-related needs. This was the objective of the second paper by Ouédraogo et al. [23] (Fig. 1: component CSA practices and technologies).

From the papers presented in this Thematic Series, important results have been generated that can be fed into policy initiatives at national level and in the region (e.g. the West Africa CSA alliance) by guiding on orientations and priorities. For instance, Etwire et al. [19] identified inexact information, complex text messages, information that are too costly to implement, and poor infrastructure as the constraints to the utilization of mobile-phone-based weather and market information, implying that properly addressing those issues is a prerequisite to promoting the use of climate services in farming communities. However, the AR4D works presented in this Thematic Series have, so far, been weakly tackled some components of the CSV approach; those components should be prioritized in future efforts of

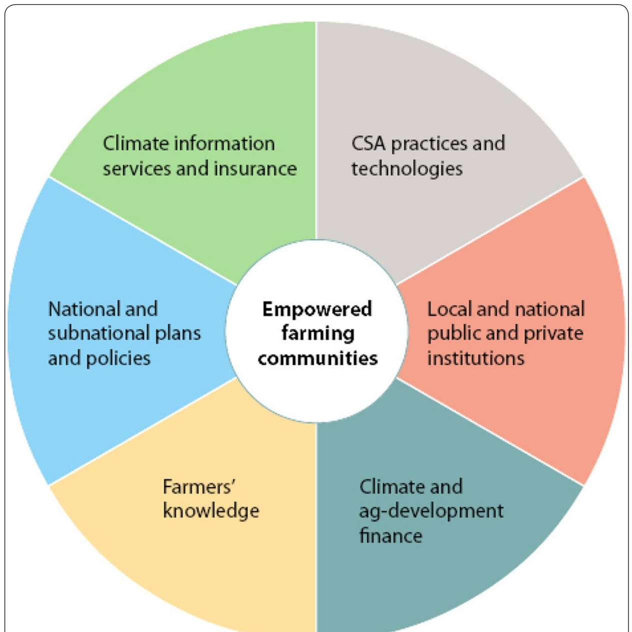

Fig. 1 Components considered in the CSV AR4D sites (taken from CCAFS [12])

action research in the sites and the region. For instance, although climate information services have become common practice (despite some weaknesses spotted out above), there is still a need to explore ways of developing climate-related agriculture insurance and offer it as potential adaptation option to farming communities. Also, more work is yet to be done to get public and private, climate and agriculture development finance institutions to support upscaling of proven CSA options.

Overall, this Thematic Series has provided ground evidences on, for instance, (1) the effectiveness of the CSV approach in engaging communities in the sustainable development of their adaptive capacity to CC [15], (2) the performance of specific CSA practices [16, 18] and (3) the requirement to match the combination of agriculture technologies/practices to the nature of the given season, i.e. the need to adapt practices to forecasts, as evidenced in Sanou et al. [17]. All this brings new scientific knowledge that could serve as guiding principles in diffusing CSA in agriculture development initiatives in West Africa, where there is already evidence of such mainstreaming request for some regional programmes.

Authors' contributions

JB and SDD wrote the manuscript. RZ and AO revised the document and added critical sections. All authors amended the earlier drafts. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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